WEEK 1; READING SUMMARIES

Principle cellular components

- NS is made of different cell types
- Neurons communicate via neurotransmitters
- Glia cells support the NS; they are the other principle cells of the NS
- Glia functions
    - astrocytes; form a barrier over the CNS and endothelium of capillaries, major metabolic function in maintaining internal milieu
    - Ependymal cells; line ventricles of the brain, regulating movement of chemicals from blood into ventricles
    - Microglia – associated with immune function in CNS
    - Oligodendrocytes + Schwann cells – provide insulation for the axons of neurons (this insulation influences conduction velocity)

PNS - somatic and autonomic NS

CNS - brain and spinal cord

- Regions – cerebrum, cerebellum, brainstem and spinal cord
- Cerebrum divisions – cortex, deep cerebral nuclei, white mater and grey matter
- Grey matter – has it's colors as there is a greater concentration of neuronal cell bodies, and less myelin.
- White matter – has tracts containing bundles of axons that provide functional links between different regions of the brain
- Deep cerebral nuclei – thalamus, hypothalamus, basal ganglia, amygdala etc
- Basal ganglia – regulates motor function
- Thalamus – regulates transmission of signals to cerebral cortex
- Hypothalamus – integrates autonomic functions and controls various hormones
- Cerebellum – (little brain) ; moto function is it's main function
- Brainstem – midbrain, pons and medulla
- Spinal cord – transmits and processes sensory and motor information to and from structures outside and inside the CNS
    - Gives rise to dorsal and ventral roots that carry sensory and motor information
    - Sensory and motor axons merge to form spinal nerves (PNS)

Meninges

- Covers the entire CNS
- Dura mater – toughest outer later; protective function
- Pia mater – closes to surface of the brain; very delicate and adhered tightly to the brain and spinal cord
- Arachnoid mater – Thinner and attaches via filamentous structures (gives it the appearance of a spiders web)

CSF and Ventricular system

- CSF (cerebrospinal fluid) occupies the space between the pia and arachnoid space (subarachnoid space)
- Made within the ventricles of the brain by the choroid plexus
- Two large lateral ventricles in each hemisphere
- Lateral ventricles are connected to the third ventricle
- The third ventricle connects to the fourth ventricle via the cerebral aqueduct

Axes and planes of section

- Rostrocaudal – longitudinal axis (e.g. snout to tail)
- Anterior and ventral / posterior and dorsal

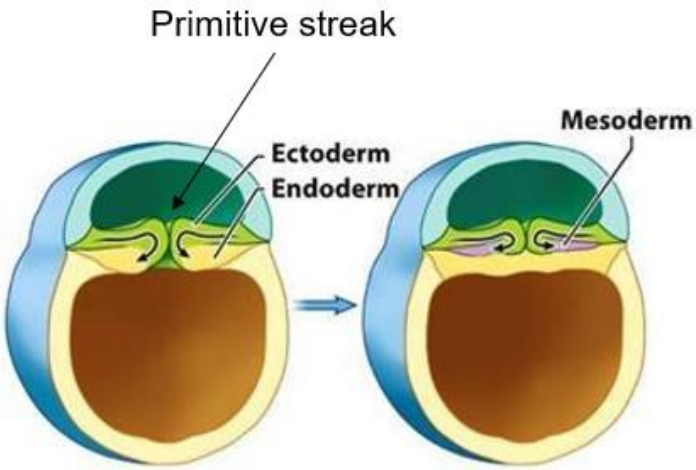
WEEK 2 NEURO DEVELOPMENT

The beginning

1. **Fertilization** - Zygote cell (1 cell) and blastula (> 100 cells)
2. **Blastula -** outer layer - placenta; inner cell mass (stem cells), embryo
3. **Gastrulation** - body plan formation (week 2)

Blastula folds upon itself, embryonic disc and the primitive streak gives rise to 3 germ layers;

- **Ectoderm** - skin and NS
- **Mesoderm** - skeletal muscle and connective tissue (cartilage, bone, blood vessels)
- **Endoderm** - alimentary, respiratory and genitourinary systems



Neural induction (ectoderm)

1. **Determination** - stem cells
2. **Differentiation -** growth factors
3. **Proliferation**
4. **Migration**
5. **Maturation** - synapse formation and refinement

Mesodermal differentiation - longitudinal growth producing somites occuring before neural tube closes

- Begins cranially; added caudally
- Form skeletal structure
- Forms meninges
- Mesoderm surrounding and growing into neural tube forms vascular system

Neurulation - formation of body tissues

- **Notocord** - develops from mesoderm → defines embryo midline; becoming axial skeleton
    - Induces overlying ectoderm neural tube y thickening of dorsal midline neural place → neural folds on either side of the neural groove
- Neural folds fuse neural tube forming CNS

Primary vesicle	Secondary vesicle	Neural derivatives	Cavity
Prosencephalon (forebrain)	Telencephalon Diencephalon	Cerebral hemispheres Thalamus, hypothalamus Retina and other structures	Lateral ventricles Third ventricle
Mesencephalon (midbrain)	Mesencephalon	Midbrain	Cerebral aqueduct
Rhombencephalon (hindbrain)	Metencephalon Myelencephalon	Pons, cerebellum Medulla	Part of 4th ventricle Part of central canal

LECTURE 3 - BLOOD SUPPLY AND CORTICAL ANATOMY

Circle of willis

- Joins anterior and posterior circulations
- Half visible in normal angiogram
- Middle cerebral A., anterio cerebral A., anterior communicating A., posterior communicating A., posterior cerebral A., internal carotid A., basilar artery

CNS region

CAROTID (ANTERIOR) CIRCULATION - 80% *(Main branches of internal carotid artery)*	
Middle cerebral artery	Basal ganglia, internal capsule, lateral ⅔ cortex, insula, limbic system (laterally)
Anterior cerebral artery	Internal capsule, medial, frontal and parietal lobes
Posterior communicating artery	Connects carotid and vertebral systems; connects anterior and posterior circulation together
Lateral lenticulostriate	**Basal ganglia (V. susceptible to pressure)**
VERTEBRAL (POSTERIOR) CIRCULATION - 20%	
Vertebral artery	Spinal cord and dorsal medulla
Basilar artery	Pons and cerebellum
Posterior cerebral artery	Midbrain, thalamus, posterior internal capsule and inferior medial temporal occipital cortices

Area	**Blood supply**
Frontal lobe	Lateral (MCA); Medial (ACA) Inferior (ACA, MCA)
Parietal lobe	Lateral (MCA); Medial (ACA)
Temporal lobe	Lateral (MCA) Medial + inferior (PCA) Temporal pole (MCA)
Occipital lobe	Lateral (MCA); Medial + inferior (PCA)

WEEK 4 - CORTICAL FUNCTIONAL ANATOMY

Frontal lobe

- **Primary motor cortex**
  - Function - execution of voluntary skilled movements
  - Located - precentral gyrus paracentral lobule on medial side
  - Lesion - contralateral (opposite side of body) paralysis
- **Premotor cortex**
  - Function - planning voluntary skilled movement
  - Location - before the pre-central gyrus
  - Lesion - motor apraxia; poor motor planning
- **Supplementary cortex**
  - Function - planning voluntary skilled movements
  - Location - medial side equivalent of pre-motor cortex
  - Lesion - no permanent loss of movement, pre-motor cortex compensates over
- **Frontal eye fields**
  - Function - planning eye movements
  - Location -
  - Lesions - ipsilateral gaze deviation, damage to LFEF (lose ability to move eye to the right)
- **Brocas area**
  - Function - expressive language
  - Location - inferior frontal gyrus
  - Lesion - expressive / brocas aphasia
- **Dorsolateral prefrontal cortex**
  - Function - decision making and empathy
  - Location - located on dominant (left side in most people), empathy (non-dominant)
  - Lesion - reduced ability to make decisions and empathise
- **Orbitofrontal cortex**
  - Function - movement and behavioral consequences (risk, reward, punishment)
  - Location - underneath the frontal pole (can only be seen on underside)
  - Lesion - Inappropriate behavior, lethargy, unmotivated

Occipital lobe

- **Primary visual cortex** - best seen on medial side
  - Function - vision, input from eyes goes to V1
  - Location - Calcarine sulcus; above and below (cuneus and lingual)
  - Lesion - L or R visual field blindness (contralateral homonymous hemianopia)
- **Secondary visual cortex**
  - Function - Interpretation of visual stimuli
  - Location - Cuneus and lingual gyrus
  - Lesion - Visual agnosia; lack of understand what is being seen

Temporal lobe

- **Primary auditory cortex**
  - Function - Sound localisation and hearing perception
  - Location - Superior temporal gyrus (middle)
  - Lesion - Cortical deafness (sound comes in but can't be interpreted)
- **Secondary auditory cortex**
  - Function - Sound interpretation
  - Location - Immediately surround A1 on superior temporal gyrus
  - Lesion - Verbal agnosia (lack of understand of what is being heard)

WEEK 4 READINGS; FUNCTIONAL ANATOMY OF CORTEX

Overview

- Primary areas – areas that have a single function (touch, vision, hearing taste and smell or voluntary movement
    - Their function is to receive and start the initial processing of information
- Association cortex – provides higher-order processing of sensory and motor information
    - Posterior parietal (association) – integrates diverse sensory integration and purposeful movements; associated with cognition of the body and awareness of objects surrounding; critical to attention of external events
    - Parieto-occipital-temporal (association) – coordinates somatosensation with visual and auditory cues to produce perceptual recognition on movements in response to visual or auditory stimuli
    - Prefrontal (association) – occupies most of the rostral part of the lateral frontal love; important in planning voluntary movements
    - Limbic (association) – associated with the medial and inferior surfaces of the brain; mostly memory, motivation and emotion
    - All association areas; feed into the higher order motor areas, which them project to the primary motor cortex; that exerts control over the motorneurons
    - Dominant hemisphere – contains centres for language production and comprehension (most people this is the left hemisphere)
        - Damage results in – speech comprehension or production difficulties
        - Language function can be determined using WADA TEST

Cerebral Cortex Histology

- 3 types of cortex in the brain
- Neocortex – newer; associated with frontal, parietal, occipital and temporal lobes
- Archicortex – the oldest; associated with the hippocampus
- Paleocortex – restricted to the base of the brain hemisphere; associated with the olfactory system
- Archicortex and paleocortex = LIMBIC SYSTEM
- Pyramidal neurons = principal output neurons of cerebral cortex
    - Excitatory and use GLUTAMATE
- Non-pyramidal cells (granule cells) = smaller
    - Mostly inhibitory and use GABA
- Afferent axons entering cerebral cortex come from association fibres, commissural fibres and from subcortical regions
- Efferent axons leaving cerebral cortex = always from pyramidal neurons and ALWAYS excitatory
- **Divided in to 6 layers**
    - Layer 1 = outermost layer
    - Layer VI = innermost layer
    - Layers II + III = neurons projecting to ipsilateral and contralateral cortex
    - Layer VI = neurons projecting to thalamus
    - Layer V = neurons projecting to other subcortical sites, brainstem and spinal cord

HYPOTHALAMUS

Hypothalamus

- **Function**
  - Commander in chief of ANS
  - Widespread connections
  - Responds to internal and external stimuli to maintain homeostasis (critical for life)
  - Regulates ANS and endocrine functions
  - Limbic and association cortices relay emotions to hypothalamus
- **Anatomical boundaries**
  - Medial wall = 3V border, superior = IVF & hypothalamic sulcus
  - Rostrocaudal = A/P commissures & lamina terminalis, fornix
  - Lateral = internal capsule (posterior)
  - Inferior = mamillary bodies & median eminence & tuber cincerum
  - Blood Supply = branches of ACA, PCA and PCom (query ICA, ACom)
- **Divisions**
  - Preoptic
  - Anterior - paraventricular, anterior, supraoptic, suprachiasmatic
  - Tuberal - dorsomedial, ventromedial, arcuate
  - Posterior - mammillary, posterior
  - Lateral - tuberomamillary, lateral
- **Homeostasis (promoted 2 ways)**
  - Neural (arousal vs Rest and digest - fast
    - Anterior group excites SNS
    - Posterior group excites SNS
  - Hormones (pituitary gland - HPA)
    - Flow - APG (releasing inhibiting hormones
    - Fast - (neurohormones)
    - Used for long and short feedback
- **Tracts**
  - Median forebrain bundle –
    - Crosses entire lateral area
    - Connects brainstem to forebrain
  - Fornix – largest tract; part of Papez circuit to hippocampus
  - Stria terminalis – major pathway to/from amygdala
  - Mammillothalamic tract – part of papez circuit
  - Dorsal longitudinal fasciculus – connections to PAG, RF and collateral input from DCML, STT, NTS
    - PAG - periaqueductal grey; descending tract for pain
    - RF - reticular formation
    - STT - subthalamic nuclei
    - NTS - Nucleus tractus solitarius (visceral input)
  - Hypothalamispinal tract – ANS output to IML of spinal cord
  - Tuberinofundibualr – arcuate nucleus to APG
  - Supraoptichypophysial – SO and PVN to PPG
- **Medial VS lateral ; feeding control**
  - External signs (lateral - feeding centre)
  - Internal signs (ventromedial - satiety centre)
  - Ghrelin - increase appetite
  - Leptin - decrease appetite
  - Orexin - increase metabolism and food craving

WEEK 6 READINGS; CEREBELLUM

Cerebellum

- Influences motor activity by comparing the motor intention with sensory feedback, and adjusting motor activity accordingly
- Influences motor activity to achieve fine coordination (particularly upper limb) and also motor activity on cranial nerves III, IV, VI (eye movements)
- Helps to maintain posture and balance
- Involved in vestibulo-ocular reflexes and visceromotor functions via the hypothalamus
- Role in acquisition of new voluntary complex motor skills (the how is not clear)

Lobes

- Anterior cerebellar lobe – control of limb and trunk movement
- Posterior cerebellar lobe – planning of movement in non-motor functions of cerebellum (cognition, emotion)
- Flocculonodular lobe – key role in maintaining balance and controlling eye movements
- 3 lobes comprised of 10 lobules made up of folia

Structures

- Superior cerebellar peduncles – contain mainly efferent from cerebellum travelling to diencephalon and brainstem
    - Contains SOME afferents from (ventral) spinocerebellar tracts, hypothalamus and brainstem
- Middle cerebellar peduncle – composed of cerebellar afferents from basilar pons
- Inferior cerebellar peduncles – has cerebellar afferents from the medulla and cord

Function areas

- Vestibulo-cerebellum –
    - Made up of – Flocculonodular lobe, and vulva
    - Function – adjusts muscle tone and motor responses to vestibular stimuli + helps maintain balance and control of head and eye movements
    - Input – from vestibular nuclei and vestibular labyrinth
    - Output – to the vestibular nuclei of the medulla and pons
- Spinocerebellum
    - Made up of – vermal and paravermal zones of the anterior and posterior lobes (excluding uvulva)
    - Function – control of posture and movement of trunk and limbs
    - Input – spinal cord (spinocerebellar tracts)
    - Output fastigial and interposed nuclei
- Cerebrocerebellum
    - Made up of – lateral cerebellar hemispheres of the anterior and posterior lobes
    - Function – planning of voluntary movement
    - Input – contralateral cerebral cortex (motor, sensory and association cortex)
    - Output – Dentate nuclei

Deep cerebellar nuclei

- 3 pairs of nuclei
    - Fastigial
    - Interposed (= globose and emboliform nuclei)
    - Dentate

(SPOT TEST STUDY)
LOBULES AND GYRI

FRONTAL LOBE

Location: In front of parietal lobe (separated by central sulcus) and above and inf front of temporal lobe (separated by lateral sulcus)

Function: Motor; control of voluntary movement, involved in; attention, memory, motivation and planning

Blood supply

- Medial surface – anterior cerebral artery (ACA)
- Lateral surface – middle cerebral artery (MCA)

PRECENTRAL GYRUS

Location: Rostral to central sulcus, caudal to precentral sulcus

Function: Primary motor cortex (MI)

Blood supply: Anterior cerebral artery (ACA)

SUPERIOR FRONTAL GYRUS

Location: Frontal lobe; runs rostrally along longitudinal fissure from pre-central sulcus to frontal pole

Function: Pre-motor cortex and supplementary motor cortex

Blood supply: Anterior cerebral artery (ACA)

CEREBELLUM

FLOCCULONODULAR LOBE

Location: Cerebellum

Function: Balance and posture

Functional zone: Vestibulocerebellum

Deep nuclei: Vestibular

ANTERIOR LOBE

Location: Cerebellum

Function: Locomotion

Functional zone: Spinocerebellum

Deep nuclei: Interposed

POSTERIOR LOBE

Location: Cerebellum

Function: Skilled motor tasks

Functional zone: Cerebrocerebellum